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PATENT
Attorney Reference Number 23-59243-01

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Re application of:

S. Thomas Autrey, Gerald J. Posakony and Chen Yu

Application No. 10/001,235

Filed: November 13, 2001

Confirmation No. 9274

For: ARRAY-BASED PHOTOACOUSTIC
SPECTROSCOPY

Examiner: Richard A. Rosenberger

Art Unit: 2877

Attorney Reference No. 23-59243-01

CERTIFICATE OF MAILING

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Attorney
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5/18/04

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TRANSMITTAL LETTER

Enclosed for filing in the application referenced above are the following:

- ☒ Appeal Brief with Appendix and attached Exhibit A (in triplicate).
- ☒ A check in the amount of \$165.00 to cover the fee for filing an Appeal Brief.
- ☒ Please charge any additional fees that may be required in connection with filing this amendment and any extension of time, or credit any overpayment, to Deposit Account No. 02-4550. A copy of this sheet is enclosed.
- ☒ Please return the enclosed postcard to confirm that the items listed above have been received.

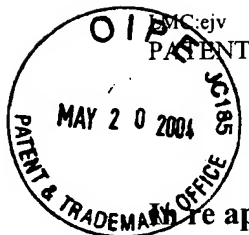
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05/18/04 13104-E 279132
PATENT

Attorney Reference Number 23-59243-01
Application Number 10/001,235

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Re application of:

S. Thomas Autrey, Gerald J. Posakony and Chen Yu

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MAIL STOP APPEAL BRIEF - PATENTS
COMMISSIONER FOR PATENTS
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APPEAL BRIEF

In accordance with 37 CFR 1.192, this Appeal Brief is being filed in triplicate together with a check in the amount of \$165.00 covering the appeal fee. The Commissioner is hereby authorized to charge any deficiency in the required fee or to credit any overpayment to Deposit Account No. 02-4550.

I. Real Party in Interest

The real party in interest is Battelle Memorial Institute, the assignee of the present application.

II. Related Appeals and Interferences

To the best of appellants', the appellants' legal representative, and assignee's knowledge, there are no related appeals or interferences.

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III. Status of Claims

Claims 1-48 and 50-51 are pending. Claim 49 has been cancelled. Claims 1-48 and 50-51 are rejected and appealed.

IV. Status of Amendments

No amendments have been filed subsequent to the Advisory Action.

V. Statement of the Invention

Disclosed in the subject application are methods and apparatus for simultaneous or sequential, rapid analysis of multiple samples by photoacoustic spectroscopy (PAS). Photoacoustic spectroscopy sample arrays 20, 120, 220, 320, 420 are disclosed (see the specification at, e.g., p. 7, ll. 15-29; p. 10, ll. 16-20; p. 10, l. 21 to p. 11, l. 4; p. 11, l. 26 to p. 12, l. 13; p. 12, l. 23 to p. 13, l. 14). The sample arrays include a support or substrate 28, 128, 228, 428 (see, e.g., p. 7, l. 30 to p. 8, l. 6) formed of material that does not significantly impede transfer of an acoustic signal. The support includes an array of affinity masses 40, 140, 240, 440 (see, e.g., p. 8, l. 7 to p. 9, l. 12). The affinity masses comprise a material capable of retaining a sample having one or more analytes or capable of retaining the analytes for PAS analysis. The affinity masses comprise material having a specific affinity (chemical or physical) for the medium containing the one or more analytes of interest or for the analytes themselves (see, e.g., p. 8, l. 7 to p. 9, l. 12). In one embodiment the affinity masses are formed on and/or connected to the sample array support (see, e.g., p. 9, ll. 13 -27). In another embodiment the sample array includes recesses formed in the support or formed in a substrate separate from or connected to a support. The recesses may retain affinity mass material for retaining analytes of interest. Alternatively, the recesses may simply retain solutions including one or more analytes of interest (see, e.g., p. 10, ll. 4-15). Further, embodiments of the sample array may include at least one acoustic detector 48, 148, 248, 448 acoustically connected to or placed in the vicinity of the support to detect acoustic signals emitted by analytes of interest retained by the affinity masses (see, e.g., p. 13, l. 29 to p. 17, l. 26; p. 19, l. 21 to p. 20, l. 14).

Also disclosed are methods for analyzing multiple analyte samples by photoacoustic spectroscopy. The multiple samples may be analyzed by PAS either sequentially or simultaneously in the sample arrays (see, e.g., p. 20, ll. 5 to p. 23, l. 19).

VI. Issues

At issue in this appeal is the propriety of the following rejection:

Whether claims 1-48 and 50-51 are unpatentable under 35 USC § 103(a) over U.S. Patent No. 4,436,428 (Watanabe).

VII. Grouping of Claims

Claims 1-2, 16, 20, 26, 27, 29, 30, 37, 39 and 45 stand together and stand separate from the other claims.

Claims 3, 8, and 12-14 stand together and stand separate from the other claims.

Claims 4, 17, and 23 stand together and stand separate from the other claims.

Claims 5, 24 and 31 stand together and stand separate from the other claims.

Claims 6 stands separate from the other claims.

Claims 7, 9, and 10 stand together and stand separate from the other claims.

Claim 11 stands separate from the other claims.

Claims 15, 28, 38, 40 and 44 stand together and stand separate from the other claims.

Claims 18 and 25 stand together and stand separate from the other claims.

Claims 19 and 34 stand together and stand separate from the other claims.

Claims 21 and 41 stand together and stand separate from the other claims.

Claims 22 and 48 stand together and stand separate from the other claims.

Claim 32 stands separate from the other claims.

Claim 33 stands separate from the other claims.

Claims 35 and 36 stand together and stand separate from the other claims.

Claim 42 stands separate from the other claims.

Claims 43, 46, 47, 50 and 51 stand together and stand separate from the other claims.

VIII. Argument

Claims 1-48 and 50-51 would not have been obvious in view of U.S. Patent No. 4,436,428 (Watanabe) because (1) Watanabe does not teach or suggest detecting an acoustic detector for detecting an acoustic signal, as claimed, and (2) for each of the additional reasons outlined below in regard to specific claims discussed. We discuss the Watanabe reference's lack

of detection of an acoustic signal in general first, as each of the appealed claims recites an apparatus having an acoustic detector or method that detects an acoustic signal. Discussion of the further differences of the present claims from the cited reference follow the general discussion.

The fundamental difference between the presently claimed invention and the cited Watanabe reference is that the Watanabe reference does not teach or suggest detecting an *acoustic signal* as claimed in the present apparatus and method claims. Despite the "photoacoustic spectroscopy" language used in the Watanabe reference, Watanabe does not teach or suggest a device that detects an "acoustic signal" as it is known to those of ordinary skill in the art.

Appellants' § 132 Declaration of Stephen Edward Bialkowski¹, a leading expert in the field of photoacoustic spectroscopy whose credentials are detailed in the Declaration, explains the fact that Watanabe – the only reference recited to reject the claims of the application – does not disclose a detector or device that detects *acoustic signals*. (The Declaration was filed with the Amendment After Final, December 19, 2003 and is attached as Exhibit A hereto.) Neither the fact that Watanabe may have misused the term "acoustic signal" nor the fact that the Examiner has a misunderstanding of the proper definition of an acoustic signal or photoacoustic spectroscopy, is controlling for interpreting the present claims. The present claims must be judged in light of correct understandings of the recited terminology by those of ordinary skill in the art. The Declaration outlines what those of ordinary skill in the art know the meaning of "acoustic signal" to be and define as such. The Watanabe reference clearly does not teach or suggest a detector that detects acoustic signals. (See, e.g., *In re Hoeksema*, 158 USPQ 596 (CCPA, 1968)).

The Examiner, in attempt to support the misinterpretation of Watanabe, cites two other patents in his Advisory Action (dated March 1, 2004), U.S. Pat. Nos. 5,348,002 and 6,108,096. However, neither of these references supports the Examiner's definition of an acoustic signal nor do the references in any manner contradict the definition of *acoustic signals* as understood by those of ordinary skill in the art, and as described in the Dr. Bialkowski Declaration. The '002 and '096 patents merely reference that samples heated with a modulated light beam will produce

¹ Note that Dr. Bialkowski is not an inventor and is not associated with the Assignee. Dr. Bialkowski is a unbiased photoacoustic spectroscopy expert.

thermal waves in the material heated that cause thermal fluctuations in the medium surrounding the irradiated material and that photoacoustic waves or signals are one possible result or physical phenomenon produced by such irradiation. The references do not in any manner indicate, however, that the flow of the medium (usually gas) generated is the acoustic signal itself, as asserted by the Examiner but only that an acoustic signal will eventually result. The Watanabe reference detects a different physical phenomenon (the flow of gas), not the resulting acoustic signal.

Specifically, in both Appellants' and Watanabe's devices, a release of energy by the molecules absorbing light cause a rise in temperature which in turn causes an increase in pressure. However, that is where the similarity in the devices and methods end. The increase in pressure causes two phenomena. One is the longitudinal pressure wave per se (i.e., an acoustic signal) and the other is mass flow (i.e., an anemometer signal) a gas flow as detected by the Watanabe device. Appellants' device measures the first listed physical phenomenon and the Watanabe measures the second listed physical phenomenon.

The acoustic signals (pressure = force/unit area) measured by Appellants' claimed apparatus move at acoustic velocities. The Watanabe apparatus instead measures with an anemometer, the mass flow (flow = volume/unit time) - the flow of a gas caused by the acoustic pressure wave (a different physical parameter or phenomenon, the one caused by the acoustic wave, not the acoustic wave itself). The gas flow measured by Watanabe moves at significantly slower velocities than do acoustic signals, i.e., not at acoustic velocities. An anemometer (as used by Watanabe) could not detect an acoustic signal. Conversely, the claimed apparatus (and methods) in Appellants' application could not detect the flow of gas that is detected in Watanabe. The fact that the two devices could not measure the physical phenomena the other is detecting (i.e., acoustic signals versus gas flow) is an undeniable indicator that Watanabe is not teaching or suggesting detecting acoustic signals as recited in the present claims.

Clearly, the Examiner's statement (e.g., Dec. 15, 2003, Office action, para. 3) that Watanabe detects an acoustic signal, is incorrect – this has been verified by an expert in the field of photoacoustic spectroscopy in the Declaration which discusses the meaning of acoustic signals as understood by those of ordinary skill in the art.

The Examiner suggests in his Advisory Action (page 5) that even if the Watanabe reference does not teach detection of an acoustic signal, it suggests detection of the same. This is also incorrect.

Watanabe actually teaches away from detecting an acoustic signal. The Watanabe reference teaches that "noise" received by a microphone (i.e., acoustic signals) is not an acceptable form of detection for his device and in fact, detection of the acoustic signals themselves is undesirable. Watanabe explicitly states that acoustic signals are not detected. See, for example, col. 4, line 66 through col. 5, line 5, where Watanabe states:

An important difference between the present invention and photoacoustic spectrometers of the prior art is the method and apparatus by means of which the oscillatory flow of fluid (gas) between reference and sample chambers 24 and 22 is detected. *Instead of using a microphone (which is sensitive to ambient noise) a plurality of hot-wire anemometers is used to form a flowmeter element, 28.*

Emphasis added. Watanabe further states that "[a]mbient noise has no effect on this flow detector." Col. 5, lines, 41-42. Thus, Watanabe in fact teaches away from the presently claimed invention.

With reference to the specific claims (as they stand together).

Claims 1-2, 16, 20, 26, 27, 29, 30, 37, 39 and 45 are patentable over Watanabe because each claim recites an acoustic detector that detects an acoustic signal. As discussed above, Watanabe does not teach or suggest a device having an acoustic detector that detects an acoustic signal. The same holds true for each and every claim appealed herein and thus, the argument will not be repeated for each but is set forth as applying to each claim in addition to the further differences set forth below. Accordingly, for the reasons discussed above, claims 1-2, 16, 20, 26, 27, 29, 30, 37, 39 and 45 are patentable over Watanabe.

Furthermore, claims 1-2, 16 and 20 are patentable over Watanabe because each claim recites a substrate and substrate is defined in the specification as being formed of material that does not significantly impede transfer of an acoustic signal (see, e.g., p. 7, l. 30 to p. 8, l. 6). Nothing in Watanabe suggests, nor does the Examiner suggest, that Watanabe has such a substrate. The Examiner points to the filter material 165 (and FIGS. 12 and 13) in Watanabe as being allegedly equivalent to the Appellants' recited affinity masses. The body 162 supporting the filter 165 (in FIG. 12) however, is not in any manner indicated to be formed of material that

does not significantly impede transfer of an acoustic signal. In fact, it need not be, because Watanabe detects gas flow, not an acoustic signal. Thus, for this additional reason, claims 1-2, 16 and 20 are patentable over Watanabe.

Claims 3, 8, and 12-14 are patentable over Watanabe because each claim recites a reflective coating transmissive to acoustic waves but reflective of light beams. The Examiner has made the completely unsupported statement (Office action, pp. 3 and 3, dated March 20, 2003) that use of such a reflective coating is known. However, since Watanabe neither teaches nor suggests such a reflective coating and no reference is cited as support and because Watanabe would not even contemplate such a reflective coating because it does not detect an acoustic signal, claims 3, 8, and 12-14 are patentable over the art of record. That is, there is no indication that Watanabe would use such a reflective coating and the Examiner has provided no support for his statement that such would be obvious.

Claims 4, 17, and 23 are patentable over Watanabe because each recites a transducer as the acoustic detector. The Examiner contends (Office action, p. 4, dated August 19, 2003) that a microphone and a transducer are equivalents. Regardless of whether they are or are not, Watanabe teaches away from using a microphone because Watanabe purposefully does not detect an acoustic signal. Instead, Watanabe uses a gas flow meter – which is incapable of detecting an acoustic signal, as discussed above. Thus, for this additional reason, claims 4, 17, and 23 are patentable over Watanabe.

Claims 5, 24 and 31 are patentable over Watanabe because each claim recites a thin-wall tube transducer. By the same reasoning discussed immediately above, the Watanabe reference neither teaches nor suggests using a thin-wall tube transducer. Thus, for this additional reason, claims 5, 24 and 31 are patentable over Watanabe.

Claim 6 is patentable over Watanabe because it recites that the transducer has a cross-sectional area that is less than or equal to an irradiated cross-sectional area of an affinity mass. The Watanabe reference neither teaches nor suggests, nor does the Examiner even contend that it teaches or suggests a transducer having a cross-sectional area that is less than or equal to an irradiated cross-sectional area of an affinity mass. As discussed above, the Watanabe reference teaches away from using a device even capable of detecting an acoustic signal. Thus, for this additional reason, claim 6 is patentable over Watanabe.

Claims 7, 9, and 10 are patentable over Watanabe because each claim recites multiple affinity masses. The Examiner never suggests that Watanabe recites multiple affinity masses but only cites to the single filter shown in FIGS. 12 and 13 of Watanabe as being an alleged example of an alleged affinity mass. It makes sense that the Examiner does not cite to multiple affinity masses in Watanabe as no such teaching or suggestion is made therein. Thus, for this additional reason, claims 7, 9 and 10 are patentable over Watanabe.

Claim 11 is patentable over Watanabe because claim 11 recites means for reflecting light away from the means for detecting acoustic signals. There is no suggestion in Watanabe (or by the Examiner) that means for reflecting light away from the means for detecting acoustic signals be included. In fact, Watanabe would not even contemplate such means for reflecting light away from the means for detecting acoustic signals because it does not teach or suggest having an acoustic detector. Thus, for this additional reason, claim 11 is patentable over Watanabe.

Claims 15, 28, 38, 40 and 44 are patentable over Watanabe because each claim recites a support having affinity masses for retaining a solvent containing an analyte, the affinity masses arranged in an n, m matrix, wherein n and m are whole numbers from about 2 to about 2000. The Examiner never suggests that Watanabe recites such an array of affinity masses but only cites to the single filter shown in FIGS. 12 and 13 of Watanabe as being an alleged example of an alleged affinity mass. The Examiner could not cite to multiple affinity masses in Watanabe as no such teaching or suggestion is made therein. Thus, for this additional reason, claims 15, 28, 38, 40 and 44 are patentable over Watanabe.

Claims 18 and 25 are patentable over Watanabe because each claim recites a contact transducer. By the same reasoning discussed above, the Watanabe reference neither teaches nor suggests using a contact transducer nor does the Examiner cite to such a suggestion in Watanabe or elsewhere. Thus, for this additional reason, claims 18 and 25 are patentable over Watanabe.

Claims 19 and 34 are patentable over Watanabe because each claim recites an acoustic detector aligned beneath each affinity mass. Watanabe neither teaches nor suggests, nor does the Examiner provide any support for suggestion of an acoustic detector aligned beneath each affinity mass. In fact, the only detector (which is a flow meter not capable of detecting acoustic signals) shown in Watanabe near anything even arguably similar to the recited affinity mass is the flow meter 170 positioned above the side of the filter 165 (see FIG. 12). Thus, for this additional reason, claims 19 and 34 are patentable over Watanabe.

Claims 21 and 41 are patentable over Watanabe because the claims recite (1) at least one affinity mass formed by masking and etching a thin film formed on the body, and (2) photolithographically forming the at least three affinity masses on a support of the sample array, respectively. The Examiner never cites a reference for such a teaching or suggestion and clearly Watanabe neither teaches nor suggests affinity masses formed by masking and etching a thin film. Watanabe's filters (cited by the Examiner as allegedly equivalent to the claimed affinity masses) couldn't, by any stretch of the imagination, be formed photolithographically. Thus, for these additional reasons, claims 21 and 41 are patentable over Watanabe.

Claims 22 and 48 are patentable over Watanabe because each claim recites two rows of affinity masses and acoustic detectors attached to each row of affinity masses. The Watanabe reference neither teaches nor suggests two rows of affinity masses or anything equivalent to affinity masses nor acoustic detectors of any kind, let alone acoustic detectors attached at the end of two rows of affinity masses. There is no other reference cited for such a teaching or suggestions. Thus, for these additional reasons, claims 22 and 48 are patentable over Watanabe.

Claim 32 is patentable over Watanabe because claim 32 recites a thin-walled transducer positioned beneath the substrate. At no time does Watanabe (or does the Examiner suggest that Watanabe) teach or suggest using either a thin-walled transducer (as discussed, a transducer couldn't detect the gas flow detected in Watanabe) or a transducer positioned beneath a substrate. Thus, for these additional reasons, claim 32 is patentable over Watanabe.

Claim 33 is patentable over Watanabe because it claim recites, in addition to those features recited in claim 31, a reflective coating positioned between a substrate and a thin-walled transducer. At no time does Watanabe (or does the Examiner suggest that Watanabe) teach or suggest using either a thin-walled transducer (as discussed, a transducer couldn't detect the gas flow detected in Watanabe) or a reflective coating positioned between a substrate and a transducer. Positioning of a reflective coating between a substrate and a Watanabe flow meter detector couldn't even work because the gas would not be able to flow to the flow meter. Thus, for these additional reasons, claim 33 is patentable over Watanabe.

Claims 35 and 36 are patentable over Watanabe because each claim recites a reflective plate connectable to and separable from the microarray plate, wherein the reflective plate is transmissive to acoustic waves and reflects light beams and a base plate connectable to and separable from the microarray plate and or the reflective plate, the base plate including multiple

acoustic detectors alignable with the multiple affinity masses of the microarray plate and capable of detecting acoustic signals. The Examiner never cites a reference that supports a teaching or suggestion of such an apparatus nor does Watanabe make any such disclosure. Thus, for these additional reasons, claims 35 and 36 are patentable over Watanabe.

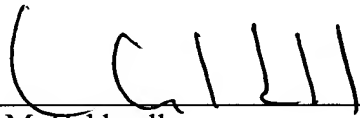
Claim 42 is patentable over Watanabe because it recites providing less than about 100 picoliters of the solutions in each of the at least two affinity masses. At no point does Watanabe (or does the Examiner suggest that Watanabe) can analyze such minute amounts of solution. Thus, for this additional reason, claim 42 is patentable over Watanabe.

Claims 43, 46, 47, 50 and 51 are patentable over Watanabe because each claim recites the simultaneous exposing of and analyses of acoustic signals emanating from multiple samples. Again, at no point does Watanabe (or does the Examiner suggest that Watanabe) can simultaneously expose and analyze acoustic signals emanating from multiple samples. In fact, as discussed in detail above, Watanabe teaches away from detecting acoustic signals. Thus, for these additional reasons, claims 43, 46, 47, 50 and 51 are patentable over Watanabe.

Respectfully submitted,

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IX. Appendix

1. A photoacoustic spectroscopy sample array comprising:
a substrate;
at least one affinity mass connected to the substrate; and
at least one acoustic detector acoustically connected to the sample array for receiving acoustic signals from the at least one affinity mass.
2. The sample array of claim 1, wherein the affinity mass is contained in a recess formed in the substrate.
3. The sample array of claim 1 further comprising a reflective coating on the substrate, wherein the reflective coating is transmissive to acoustic waves and reflects light beams.
4. The sample array of claim 1, wherein the acoustic detector comprises a transducer.
5. The sample array of claim 4, wherein the transducer is a thin-wall tube transducer.
6. The sample array of claim 4, wherein the transducer has a cross-sectional area that is less than or equal to an irradiated cross-sectional area of an affinity mass.
7. A microarray plate for PAS analysis comprising:
a body having multiple affinity masses capable of retaining specific analytes; and
at least one acoustic detector positioned adjacent each affinity mass capable of detecting acoustic signals that emanate from an analyte retained by the adjacent affinity mass.
8. The sample array of claim 7 further comprising a reflective coat connected to the body, wherein the reflective coat is transmissive to acoustic waves and reflects light beams.

9. A sample array for PAS analysis comprising:
a body having multiple affinity masses for holding multiple samples for PAS analysis;
and

means for detecting acoustic signals that emanate from the multiple samples in the multiple affinity masses, wherein the means for detecting acoustic signals is connected to the sample array.

10. The sample array of claim 9, wherein the affinity masses are contained in recesses formed in or connected to the body, wherein the affinity masses have affinities for at least one analyte of interest to be analyzed by PAS.

11. The sample array of claim 10 further including means for reflecting light away from the means for detecting acoustic signals.

12. A sample array for PAS analysis comprising:
a body having an upper surface and a lower surface;
at least one affinity mass formed on the upper surface for holding a sample for PAS analysis;
a reflective coat connected to the lower surface for reflecting light beams that pass through the at least one affinity mass; and
an acoustic detector positioned to detect and capable of detecting acoustic signals that emanate from the sample in the at least one affinity mass.

13. The sample array of claim 12, wherein an acoustic detector is positioned adjacent each affinity mass to detect acoustic signals that emanate from the adjacent affinity mass.

14. The sample array of claim 12, wherein the acoustic detector is air-coupled to the sample array.

15. A PAS sample array comprising:
a support having affinity masses for retaining a solvent containing an analyte, the affinity masses arranged in an n, m matrix, wherein n and m are whole numbers from about 2 to about 2000; and
at least one acoustic detector positioned to receive and capable of detecting acoustic signals from the analyte in at least one affinity mass.

16. A sample array comprising:
a substrate;
at least one affinity mass in a recess formed in the substrate, the affinity mass having a specific affinity for an analyte to be detected by PAS analysis; and
at least one acoustic detector fixed to the substrate and capable of receiving acoustic signals from an analyte in the at least one affinity mass.

17. The sample array of claim 16, wherein the acoustic detector comprises a transducer.

18. The sample array of claim 17, wherein the transducer is a contact transducer.

19. The sample array of claim 16, wherein an acoustic detector is aligned beneath each affinity mass.

20. A sample array for PAS analysis of analytes in a solvent, the sample array comprising:
a substrate having at least one recess containing an affinity mass having an affinity for one or more analytes;
a reflective coat on the substrate for reflecting light beams that pass through the at least one affinity mass and transmitting acoustic signals emanating from the one or more analytes in the affinity mass; and
at least one detector positioned by each recess capable of detecting acoustic signals that emanate from at least one analyte in the affinity mass.

21. A photoacoustic spectroscopy sample array comprising:
a body;
at least one affinity mass formed by masking and etching a thin film formed on the body;
and
at least one acoustic detector acoustically positioned adjacent each affinity mass and
capable of detecting acoustic signals.

22. A PAS sample array for analyzing multiple samples by PAS, comprising:
a substrate;
at least two rows of affinity masses supported by the substrate, the affinity masses
retaining the multiple samples; and
an acoustic detector fixed to each row of affinity masses on the substrate capable of
receiving acoustic signals from a sample in an affinity mass in a respective row of affinity
masses.

23. The sample array of claim 22, wherein the acoustic detector comprises a
transducer.

24. The sample array of claim 22, wherein the acoustic detector comprises a thin-wall
tube transducers.

25. The sample array of claim 23, wherein the transducer is a contact transducer.

26. The sample array of claim 23, wherein the transducer is air-coupled to the
sample array.

27. A photoacoustic spectroscopy sample array, comprising:
a body;
at least one affinity mass connected to the body;
a sealing plate for sealing the affinity mass on the body; and

at least one acoustic detector acoustically connected to the sample array and capable of detecting acoustic signals from an analyte retained by the at least one affinity mass.

28. A PAS sample array comprising:
a substrate having multiple affinity masses formed thereon for retaining an analyte, the affinity masses arranged in an n, m matrix, wherein n and m are whole numbers from about 2 to about 2000; and
at least one transducer connected to the substrate adjacent each affinity mass to receive an acoustic signal from an analyte retained by the adjacent affinity masses.

29. A photoacoustic spectroscopy sample array, comprising:
a body;
at least one affinity mass formed on the body;
at least one transducer acoustically connected to the at least one affinity mass and capable of detecting acoustic signals; and
an amplifier attached to the at least one transducer.

30. The sample array of claim 29, wherein the at least one affinity mass is deposited into a recess formed in the body.

31. A sample array for retaining at least one analyte for PAS comprising:
a substrate having a matrix of affinity masses formed on the substrate, wherein the affinity masses have a specific affinity for the at least one analyte; and
a thin-wall tube transducer positioned adjacent each affinity mass capable of receiving acoustic signals from the at least one analyte and converting the acoustic signals into electrical signals.

32. The sample array of claim 31, wherein the thin-wall tube transducers are positioned beneath the substrate.

33. The sample array of claim 31 further comprising a reflective plate positioned between the substrate and the thin-wall tube transducers.

34. A PAS sample array comprising:
a substrate having an upper surface and a lower surface;
an array of affinity masses connected to the upper surface of the substrate;
a reflective plate connected to the lower surface of the substrate; and
a base plate having an array of acoustic detectors connected thereto, wherein the base plate is positionable beneath the substrate such that each acoustic detector of the array connected to the base plate is positioned below an affinity mass, wherein each acoustic detector can receive acoustic signals emitted from an analyte retained in a respective affinity mass.

35. A sample array assembly for retaining multiple samples for PAS analysis comprising:
a microarray plate having multiple affinity masses for retaining samples for PAS analysis;
a reflective plate connectable to and separable from the microarray plate, wherein the reflective plate is transmissive to acoustic waves and reflects light beams; and
a base plate connectable to and separable from the microarray plate and or the reflective plate, the base plate including multiple acoustic detectors alignable with the multiple affinity masses of the microarray plate and capable of detecting acoustic signals.

36. The sample array of claim 35, wherein the affinity masses are contained in recesses formed in the microarray plate.

37. A method for speciating and quantifying analytes in a solvent, the method comprising:
providing a sample array having at least one affinity mass affixed thereto, the affinity mass retaining a solvent;
exposing the affinity mass to an intermittent light beam optically directed to illuminate analytes in the solvent;

placing at least one acoustic detector adjacent the sample array; and
detecting acoustic signals generated by analytes in the solvent as the solvent is exposed to the intermittent light beam.

38. A method for PAS analysis of analytes in a solution, the method comprising:
providing a sample array having a matrix of at least three affinity masses;
exposing the affinity masses to the solution such that the affinity masses retain the analytes in the solution;

exposing the affinity masses to a light beam to cause analytes retained by the affinity masses to emit acoustic signals;

placing at least one acoustic detector adjacent the sample array; and

detecting the acoustic signals generated by analytes retained by the affinity masses.

39. The method of claim 38, wherein the step of detecting the acoustic signals comprises detecting acoustic signals emanating from each affinity mass with separate transducers.

40. A method of analyzing samples containing analytes of interest, the method comprising:

providing a sample array including at least three affinity masses attached thereto, the affinity masses retaining the analytes of interest; and

analyzing the analytes retained by the affinity masses of the sample array utilizing photoacoustic spectroscopy by detecting acoustic signals emanating from the analytes.

41. The method of claim 40, wherein the step of providing at least three affinity masses comprises photolithographically forming the at least three affinity masses on a support of the sample array.

42. A method of analyzing multiple solutions including analytes of interest, the method comprising:

providing a sample array having at least two affinity mass;

providing less than about 100 picoliters of the solutions in each of the at least two affinity masses; and

analyzing the analytes of interest in the at least two affinity masses utilizing photoacoustic spectroscopy and detecting acoustic signals emanating from the analytes.

43. A method for PAS analysis of analytes, the method comprising:
providing a sample array retaining multiple samples having analytes therein;
simultaneously exposing the samples to light beams to cause analytes in the samples to emit acoustic signals;
placing at least one acoustic detector adjacent each sample; and
simultaneously detecting the acoustic signals generated by analytes in the samples.

44. The method of claim 43, wherein the step of providing a sample array retaining multiple samples comprises providing a sample array having at least four affinity masses capable of retaining the samples when exposed to the samples.

45. A method for PAS analysis of analytes, the method comprising:
providing a sample array having multiple affinity masses capable of retaining analytes therein;
sequentially exposing each affinity mass to a light beam to cause analytes in the affinity mass to emit acoustic signals;
placing an acoustic detector adjacent the affinity mass prior to exposure of the affinity mass to the light beam; and
detecting the acoustic signals generated by analytes in the affinity mass immediately after the affinity mass is exposed to the light beam.

46. A method for PAS analysis of analytes, the method comprising:
placing a sample array retaining multiple samples having analytes therein, in a PAS system;
simultaneously exposing the samples to light beams to cause analytes in the samples to emit acoustic signals; and

simultaneously detecting the acoustic signals generated by analytes in the samples.

47. The method of claim 46, wherein the multiple samples comprise affinity masses to retain the analytes.

48. A method for PAS analysis of analytes in a solution, the method comprising:
providing a single sample array having a matrix of at least two rows of affinity masses, each affinity mass retaining a solution for PAS analysis;

sequentially exposing the solutions in the at least two rows of affinity masses to light beams to cause analytes in the solutions to emit acoustic signals;

placing an acoustic detector at each row of affinity masses; and

sequentially by row detecting the acoustic signals generated by analytes in the solutions in the affinity masses.

50. A method for PAS analysis for at least one analyte comprising:
providing a substrate having at least three affinity masses formed thereon, wherein the affinity masses have specific affinities for at least one analyte;

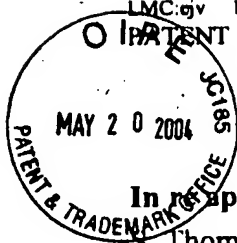
substantially simultaneously exposing the at least three affinity masses to irradiation; and
substantially simultaneously detecting acoustic waves emanating from the at least three affinity masses to determine whether the at least one analyte is present in the affinity masses.

51. A method for PAS analysis of analytes in a solution, the method comprising:
providing a substrate having a matrix of at least four affinity masses connected thereto, the affinity masses having affinities for the solutions and or the analytes;

substantially simultaneously exposing the affinity masses to light beams to cause analytes to emit acoustic signals;

placing at least one acoustic detector adjacent each affinity mass; and

substantially simultaneously detecting the acoustic signals generated by analytes in the affinity masses.



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

S. Thomas Autrey, Gerald J. Posakony and Chen Yu

Application No. 10/001,235

Filed: November 13, 2001

Confirmation No. 9274

For: ARRAY-BASED PHOTOACOUSTIC
SPECTROSCOPY

Examiner: Richard A. Rosenberger

Art Unit: 2877

Attorney Reference No. 23-59243

CERTIFICATE OF MAILING

I hereby certify that this paper and the documents referred to as being attached or enclosed herewith are being deposited with the United States Postal Service as First Class Mail in an envelope addressed to: MAIL STOP AF, COMMISSIONER FOR PATENTS, P.O. BOX 1450, ALEXANDRIA, VA 22313-1450 on the date shown below.

Attorney
for Applicant(s)

Date Mailed

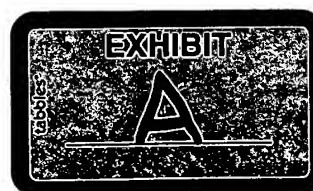
12/19/03

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DECLARATION OF STEPHEN EDWARD BIALKOWSKI

I, Dr. Stephen Edward Bialkowski, hereby declare as follows:

1. I received a Bachelor of Science degree in Professional Chemistry from Eastern Michigan University in 1975 and a Doctor of Philosophy degree in Chemistry from the University of Utah in 1978.
2. From 1978-1980, I was appointed a NRC Postdoctoral Fellow at the National Bureau of Standards and was a visiting scientist at the University of Utah in 1980. From 1980-1983, I was an Assistant Professor of Chemistry at Michigan Technology University. From 1983-1993, I was an Assistant and an Associate Professor of Chemistry at Utah State University. From 1993 to the present I have served as a Professor of Chemistry at Utah State University.
3. I am a member of the following organizations: American Association for the Advancement of Science; American Chemical Society; American Geophysical Union; International Chemometrics Society (Founding Member); Optical Society of America; Society for Applied Spectroscopy; Utah Academy of Sciences, Arts, and Letters.
4. I am an expert in, *inter alia*, photothermal spectroscopy, including photoacoustic spectroscopy, as evidenced by at least the following:



- (a) the numerous articles on the subject of spectroscopy I have authored (see Exhibit A – List of Publications);
 - (b) the leading photothermal spectroscopy technical reference entitled Photothermal Spectroscopy Methods for Chemical Analysis, which I authored (see Exhibit B – web site page describing the reference);
 - (c) the numerous Photothermal Spectroscopy Symposia and Meetings which I organized and in which I have participated (see Exhibit C – List of Symposia, Meetings, Panels, Chairmanships, and Professional Affiliations);
 - (d) the numerous Spectroscopy Panels and Chairmanships in which I participate (see Exhibit C); and
 - (e) the many Technical Journals for which I am a Reviewer, including but not limited to Applied Spectroscopy (see Exhibit C).
5. I am familiar with the invention disclosed and claimed in the above-referenced patent application ("the Application").
6. I am not a co-inventor of the subject matter described and claimed in the Application.
7. I am familiar with the reference currently cited by the Patent and Trademark Office against the Application – Watanabe et al., U.S. Patent Number 4,436,428 ("Watanabe").
8. The invention disclosed and claimed in the Application detects an acoustic signal. Despite the "photoacoustic spectroscopy" language used in the Watanabe reference, Watanabe does not teach or suggest a device that detects an "acoustic signal" as it is known to those of ordinary skill in the art.

More specifically, the Application describes an apparatus that detects acoustic signals (i.e., longitudinal pressure waves) generated by the absorption of light by particular samples. The Application discloses an invention that uses a unsealed array to detect multiple samples, either sequentially or simultaneously, by using a piezoelectric transducer to detect acoustic signals (longitudinal pressure waves) due to absorption of a pulsed light source by samples. The pulsed light strikes the samples leading to several physical changes. In the Application's disclosed invention the signal detected is the longitudinal pressure wave (i.e., the acoustic signal) launched through the solid matrix, not the expansion of the solid compressing the gas above the sample. The acoustic signal (longitudinal pressure wave) detected by the piezoelectric detector travels at the speed of sound through the sample and array apparatus. The longitudinal pressure

wave (acoustic signal) strikes the piezoelectric detector giving rise to a voltage across the piezoelectric device. The magnitude of the signal is dependent on the concentration of sample and independent of the frequency of the pulsed light source.

Watanabe describes an apparatus that detects flow of a gas rather than detecting an acoustic signal (a longitudinal pressure wave). More specifically, Watanabe uses a hermetically sealed sample and reference chamber to detect a sample by using an anemometer to detect the flow of a gas arising from the expansion of the sample substrate due to the absorption of a modulated light source. The modulated light strikes the sample leading to several physical changes. In Watanabe the signal detected is the flow of gas above the solid sample past the anemometer due to the periodic expansion of the solid compressing the gas above. The Watanabe apparatus measures the flow of gas due to the expansion of the heated sample. The induced flow of the gas passes the wires of the anemometer at subsonic rates. The magnitude of the fluid flow signal is dependent upon the thermal diffusion properties of the gas and sample, the frequency of the modulated light source absorbed by the sample, in addition to the absorption depth of the sample.

There are several very notable differences between the invention disclosed in the Application and the device described in Watanabe. One important difference is that each detects different types of signals – that is, each relies on the measurement of very different physical phenomena that result from the absorption of light by a sample. In both cases the release of energy by the molecules absorbing light causes a rise in temperature which in turn causes an increase in pressure. However, the increase in pressure causes two phenomena. One is the longitudinal pressure wave per se (i.e., the acoustic signal) and the other is mass flow (i.e., the anemometer signal).

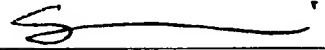
The invention disclosed and claimed in the Application measures acoustic signals, longitudinal pressure waves, (pressure = force/unit area) with a piezoelectric transducer. These acoustic signals move at acoustic velocities. The Watanabe apparatus does not measure an acoustic signal but instead measures the flow of a gas with an anemometer (flow = volume/unit time). The gas flow measured by Watanabe moves at significantly slower velocities, i.e., not at acoustic velocities.

Since the invention disclosed in the Application does not include a hermetically sealed device, an anemometer such as used by Watanabe could not be used in the Application device to

detect the acoustic signals. Furthermore, an anemometer could not detect an acoustic signal (which by definition is a longitudinal pressure wave that travels at the velocity of sound) even in a hermetically sealed device. Conversely, the invention disclosed in the Application could not detect the flow of gas that is detected in Watanabe.

9. I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true. I further understand that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001, and that such willful false statements may jeopardize the validity of the above-referenced Application or any patent issuing thereon.

Date: 12/17/2003

By: 

Name: Dr. Stephen Edward Bialkowski

Title: Professor

Exhibit A - List of Publications

PUBLICATIONS:

1. *The Infrared Multiphoton Photochemistry of Methanol* Stephen E. Bialkowski and William A. Guillory **Journal of Chemical Physics** 67 2061 1977
2. *Interface Between a Biomation 8100 and a Remote Computer for Data Acquisition in TEA-CO₂ Laser Induced Photochemistry* Stephen E. Bialkowski and William A. Guillory **Review of Scientific Instruments** 48 115 1977
3. *Collisionless Formation and Rovibronic Relaxation of CH and OH from the IR Multiphoton Photolysis of CH₃OH* Stephen E. Bialkowski and William A. Guillory **Journal of Chemical Physics** 68 3339 1978
4. *The Infrared Photolysis of SO₂* Stephen E. Bialkowski and William A. Guillory **Chemical Physics Letters** 60 429 1979
5. *Infrared Photolysis of Methanol and Monomethylamine (Dissertation)* University Microfilms Ann Arbor, MI. 1979
6. *Gas Phase Laser Induced Fluorescence Spectroscopy of CFCI* Stephen E. Bialkowski, David S. King, and John C. Stephenson **Journal of Chemical Physics** 71 4010 1979
7. *The Determination of Mass Transport Coefficients and Vibrational Relaxation Rates of Species Formed in Laser Photolysis Experiments* Stephen E. Bialkowski, David S. King, and John C. Stephenson **Journal of Chemical Physics** 72 1156 1980
8. *Energy Partitioning in the IR Multiphoton Dissociation of Molecules: Energy of XCF₂ and XCFCl from CF₂CFCI* John C. Stephenson, Stephen E. Bialkowski, and David S. King **Journal of Chemical Physics** 72 1161 1980
9. *Simple Parallel Interface Between an Optical Multichannel Analyzer and a Microprocessor* Stephen E. Bialkowski **Review of Scientific Instruments** 51 850 1980
10. *A Quantitative Test of Unimolecular Rate Theory in the Multi-Photon Dissociation of CF₂CFCI* John C. Stephenson, Stephen E. Bialkowski, David S. King, Everet Thiele, James Stone and Myron F. Goodman **Journal of Chemical Physics** 74 3905 1981
11. *Selection Rules and Linestrength Factors for Multiphoton Transitions in Gas Phase Molecular Spectroscopy* Stephen E. Bialkowski and William A. Guillory **Chemical Physics** 55 229 1981
12. *Absolute Reaction Rate Constants of CFCI X(1) Reactions with Nitrogen Oxides* Stephen E. Bialkowski and William A. Guillory **Journal of Physical Chemistry** 86 2007 1982
13. *Vibronic Relaxation Dynamics of the σ^*_g State of C₃* Y. Gu, Michael L. Lesiecki, Stephen E. Bialkowski, and William A. Guillory **Chemical Physics Letters** 92 443 1982
14. *On the Determination of Kinetic Rate and Mass Transport Coefficients in Laser Pump-Probe Experiments* Stephen E. Bialkowski **Chemical Physics Letters** 83 341 1981
15. *A Statistical Interpretation of the Rotational Temperature of NO Desorbed for Ru(001)* Stephen E. Bialkowski **Journal of Chemical Physics** 78 600 1983
16. *Chemical Reactions Following the IRMPD of C₂F₃Cl* George R. Long, Linda D. Prentice and Stephen E. Bialkowski **Applied Physics B** 34, 97 1984
17. *The Effect of Mass Diffusion in Gas Phase Thermal Lens Experiments* Stephen E. Bialkowski **Chemical Physics Letters** 104 448 1984
18. *Pulsed Infrared Laser Thermal Lens Spectrophotometric Determination of Trace Level Analytes: Quantitation of Parts Per Billion Dichloro-difluoro-methane* George R. Long and Stephen E. Bialkowski **Analytical Chemistry** 56 2806 1984
19. *Saturation Effects of Gas Phase Photothermal Deflection Spectrometry* George R. Long and Stephen E. Bialkowski **Analytical Chemistry** 57 1079 1985
20. *Pulsed Infrared Laser Thermal Lens Spectrometry of Flowing Gas Samples* Scott L. Nickolaisen and Stephen E. Bialkowski **Analytical Chemistry** 57 758 1985
21. *Photothermal Lens Aberration Effects in Two Laser Thermal Lens Spectrometry* Stephen E. Bialkowski **Applied Optics** 24 2792 1985

22. *Pulsed Laser Thermal Lens Spectrophotometry of Flowing Samples* Scott L. Nickolaisen and Stephen E. Bialkowski **IEEE Technical Digest** CH21741 110 1985
23. *Pulsed Laser Thermal Lens Spectrometry for Flowing Liquid Detection* Scott L. Nickolaisen and Stephen E. Bialkowski **Analytical Chemistry** 58 215 1986
24. *Error Reduction in Pulsed Infrared Laser Photothermal Deflection Spectrometry* George R. Long and Stephen E. Bialkowski **Analytical Chemistry** 58 80 1986
25. *A Least Squares Digital Filter for Repetitive Data Acquisition* Scott L. Nickolaisen and Stephen E. Bialkowski **Journal of Chemical Information and Computer Science** 26 57 1986
26. *Pulsed Laser Thermal Lens Spectrophotometry of Liquid Samples Using an Optical Fiber Beam Guide with Interference Orthogonal Signal Processing* Stephen E. Bialkowski **Analytical Chemistry** 58 1706 1986
27. *Binary Code Decimal to Binary Program Modification of a Popular Digital Delay Module* Stephen E. Bialkowski **Review of Scientific Instruments** 57 1431 1986
28. *Species Selective Detection in Gas Chromatography Through Photothermal Deflection Spectroscopy* Scott L. Nickolaisen and Stephen E. Bialkowski **Journal of Chromatography** 366 127 1986
29. *A Scheme for Species Discrimination and Quantitative Estimation Using Incoherent Linear Optical Signal Processing* Stephen E. Bialkowski **Analytical Chemistry** 58 2561 1986
30. *Pulsed Infrared Laser Photothermal Spectroscopy in Gas Phase Chemical Analysis* Stephen E. Bialkowski **IEEE Technical Digest** 86CH2274-9 72 1986
31. *Pulsed-Laser Photothermal Spectroscopy* Stephen E. Bialkowski **Spectroscopy** 1 26 1986
32. *Optimal Estimation of Impulse-Response Signals Through Digital Innovations and Matched Filter Smoothing* Stephen E. Bialkowski **Review of Scientific Instruments** 58 687 1987
33. *Quantitative Discrimination of Gas Phase Species Based On Single-Wavelength Non-Linear Intensity Dependent Pulsed Infrared Laser Excited Photothermal Deflection Signals* Stephen E. Bialkowski and George R. Long **Analytical Chemistry** 59 873 1987
34. *Simple Scheme for Variable High Power Laser Beam Attenuation* Stephen E. Bialkowski **Review of Scientific Instruments** 58 2338 1987
35. *Pulsed Laser Photothermal Spectroscopy* Stephen E. Bialkowski **Advances in Laser Science, AIP Proceedings** 172 738 1988
36. *Real Time Digital Filters: Finite Impulse-Response Filters* Stephen E. Bialkowski **Analytical Chemistry** 60 355A 1988
37. *Real Time Digital Filters: Infinite Impulse-Response Filters* Stephen E. Bialkowski **Analytical Chemistry** 60 403A 1988
38. *Optical Processing of Time Varying Pulsed Laser Excited Photothermal Spectroscopy Signals with Matched Filter Smoothing* Stephen E. Bialkowski and Salvador Herrera **Analytical Chemistry** 60 1586 1988
39. *Optimized Spectroscopic Signal Estimates Using Integration and Matched Filters* Stephen E. Bialkowski **Applied Spectroscopy** 42 807 1988
40. *Ultrasensitive Photothermal Deflection Spectrometry Using an Analyzer Etalon* Stephen E. Bialkowski and Zhi-Fang He **Analytical Chemistry** 60 2674 1988
41. *Theoretical Accounting for the Acoustic Energy Produced by Pulsed Laser Excitation of Optically Thin Samples* Stephen E. Bialkowski **Chemical Physics Letters** 151 88 1988
42. *Generalized Digital Smoothing Filters Made Easy by Matrix Calculations* Stephen E. Bialkowski **Analytical Chemistry** 61 1308 1989
43. *Data Analysis in the Shot Noise Limit Part I: Single Parameter Estimation with Poisson and Normal Probability Density Functions* Stephen E. Bialkowski **Analytical Chemistry** 61 2479 1989
44. *Data Analysis in the Shot Noise Limit Part II: Methods for Data Regression* Stephen E. Bialkowski **Analytical Chemistry** 61 2483 1989
45. *Application of the BaTiO₃ Beam Fanning Limiter as an Adaptive Spatial Filter for Signal Enhancement in Pulsed Laser Excited Photothermal Spectroscopy* Stephen E. Bialkowski **Optics Letters** 14 1020 1989

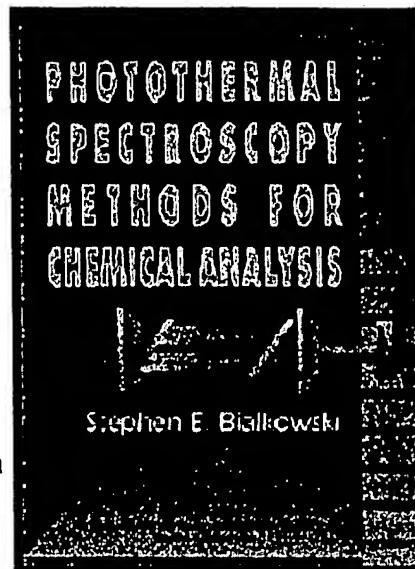
46. *Survey of Properties of Volume Holographic Materials* Richard D. Rallison and Stephen E. Bialkowski in *Practical Holography III SPIE Proceedings* 1051 68 1989
47. *Data Analysis in the Shot Noise Limit Part III: An Adaptive Method for Data Smoothing* Stephen E. Bialkowski *Journal of Chemometrics* 4 271 1990
48. *Exchange of Comments on Data Analysis in the Shot Noise Limit Part I: Single Parameter Estimation with Poisson and Normal Probability Density Functions* Stephen E. Bialkowski *Analytical Chemistry* 62 2141 1990
49. *Expectation-Maximization Algorithm for Regression, Deconvolution, and Smoothing of Shot-Noise-Limit Data* Stephen E. Bialkowski *Journal of Chemometrics* 5 211 1991
50. *Using Optical Novelty Filters in Analytical Spectroscopy* Stephen E. Bialkowski *Proceeding of the Society for Optical and Quantum Electronics* 1991 780 1991
51. *Diffraction Properties of Gelatin as an Aerogel* Richard D. Rallison and Stephen E. Bialkowski *Diffraction Optics: Design, Fabrication, and Applications Technical Digest* (Optical Society of America, Washington, D.C.) 9 111-113 1992
52. *Transition Saturation in Ethylene Observed with Infrared Photothermal Spectrometry* Stephen E. Bialkowski and Zhi-Fang He *Environmental and Process Monitoring Technologies* Tuan Vo-Dinh, Editor *SPIE Proceedings* 1637 134 1992
53. *Comparison of BaTiO₃ Optical Novelty Configuration and Photothermal Lensing Configuration in Photothermal Experiments* Shashi D. Kalaskar and Stephen E. Bialkowski *Analytical Chemistry* 64 1824 1992
54. *Pulsed-Laser Excited Differential Photothermal Deflection Spectrometry* Stephen E. Bialkowski, Xu Gu, Pete E. Poston, and Linda S. Powers *Applied Spectroscopy* 46 1335 1992
55. *Analysis of 1st-Order Rate Constant Spectra With Regularized Least-Squares and Expectation Maximization: 1. Theory and Numerical Characterization* Brett T. Stanley, Stephen E. Bialkowski, and David B. Marshall *Analytical Chemistry* 65 259 1993
56. *A Comparison of Three Multi-Platform Message-Passing Interfaces on an Expectation Maximization Algorithm* Csaba Gyulai, Stephen E. Bialkowski, Gardner S. Stiles, and Linda S. Powers in *Transputer Applications and Systems '93, Vol. 1 Proceedings of the 1993 World Transputer Congress* R. Grebe, J. Hektor, S. C. Hilton, M. R. Jane, and P. H. Welch, Eds. IOS Press, Amsterdam, pp. 451-464 1993
57. *Accounting for Saturation Effects in Pulsed Infrared Laser Excited Photothermal Spectroscopy* Stephen E. Bialkowski *Applied Optics* 32 3177 1993
58. *Optical Bleaching Kinetics of Ethylene Observed with Pulsed Infrared Laser Excited Photothermal Lens Spectrometry* Stephen E. Bialkowski and Z. F. He *Longer Wavelength Lasers and Applications* Gabor Patonay, Ed. *SPIE Proceedings* 2138 140 1994
59. *Obtaining Accurate Measurements of Organic Dye Solutions using Pulsed Laser Photothermal Deflection Spectroscopy* Agnès Chartier and Stephen E. Bialkowski *Analytical Chemistry* 67 2672 1995
60. *Laser Excited Fluorescence of Dityrosine* Sahar F. Mahmoud and Stephen E. Bialkowski *Applied Spectroscopy* 49 1669 1995
61. *Detection of Dityrosine in Apoferritin* Sahar F. Mahmoud and Stephen E. Bialkowski *Applied Spectroscopy* 49 1677 1995
62. *Photothermal Spectroscopy Methods for Chemical Analysis* Stephen E. Bialkowski, Volume 134 in *Chemical Analysis*, Wiley, New York, 1996
63. *Sub-Shot-Noise Light Sources: A Quiet Revolution in Light Control* Stephen E. Bialkowski *Critical Reviews in Analytical Chemistry* 26 101 1996
64. *Diffraction Effects in Single- and Two-Laser Photothermal Lens Spectroscopy* Stephen E. Bialkowski and Agnès Chartier *Applied Optics* 36 6711 1997
65. *Photothermal Lens Spectrometry of Homogeneous Fluids with Incoherent White-Light Excitation Using a Cylindrical Sample Cell* Agnès Chartier and Stephen E. Bialkowski *Optical Engineering* 36 303 1997

66. *Temperature-Dependent Electron Capture Detector Response to Common Alternative Fluorocarbons* Sonia R. Sousa and Stephen E. Bialkowski **Analytical Chemistry** 69 3871 1997
67. *Molecular Interactions at Octadecylated Chromatographic Surfaces* James W. Burns, Stephen E. Bialkowski, and David B. Marshall **Analytical Chemistry** 69 3861 1997
68. *Overcoming the Multiplex-Disadvantage using Maximum-Likelihood Inversion* Stephen E. Bialkowski **Applied Spectroscopy** 52 591 1998
69. *Progress Toward a Better Understanding of Signal Generation Processes in the Laser-Excited Photothermal Spectroscopy of Homogeneous Samples* Stephen E. Bialkowski **Trends in Analytical Chemistry** 17 520-532 1998
70. *Laser-Excited Photothermal Lens Spectrometry in a Low-Volume Cylindrical Sample Cell* Stephen E. Bialkowski **Israel Journal of Chemistry** 38 159-167 1998
71. *Methods for Modeling and Diagnosis of Nonlinear Absorption in Photothermal and Photoacoustic Spectrometry of Homogeneous Fluids* Stephen E. Bialkowski and Agnès Chartier **Photoacoustic and Photothermal Phenomena**, F. Scudieri and M. Bertolotti, Ed., AIP Conference Proceedings 463 46-49 1999
72. *Using Slow Measurement Systems to Measure Fast Excited-State Kinetics with Nonlinear Rate-Competitive Optical Bleaching* Stephen E. Bialkowski and Agnès Chartier **Photoacoustic and Photothermal Phenomena**, F. Scudieri and M. Bertolotti, Ed. AIP Conference Proceedings 463 14-17 1999
73. *Using an Optical Novelty Filter to Enhance Contrast in Photothermal Refraction Spectrometry* Stephen E. Bialkowski **Photoacoustic and Photothermal Phenomena**, F. Scudieri and M. Bertolotti, Ed., AIP Conference Proceedings 463 67-71 1999
74. *Using Sub-Microliter Cylindrical Sample Cells for Photothermal Lens Spectrometry of Stable and Photo-Labile Species* Stephen E. Bialkowski and Agnès Chartier, **Photoacoustic and Photothermal Phenomena**, F. Scudieri and M. Bertolotti, Ed., AIP Conference Proceedings 463 226-228 1999
75. *Fractured Zone Plates for Spatial Separation of Frequencies*, Richard D. Rallison and Stephen E. Bialkowski **Proc. SPIE-Int. Soc. Opt. Eng.** 3633 92-102 2000
76. *Thermal Lens Calorimetry: A Novel Approach to the Study of Thermodynamics* George R. Long and Stephen E. Bialkowski **Chemical Educator** 5, 145-148 2000
77. *Optical Bleaching in Continuous Laser Excited Photothermal Lens Spectrometry* Agnès Chartier and Stephen E. Bialkowski **Applied Spectroscopy** 55, 84-91 2001
78. *Comparison of Detection Limits and Relative Responses for Alternative Fluorocarbons by GC-ECD, GCAED, and GC-MS* Sonia R. Sousa and Stephen E. Bialkowski **Anal. Chim. Acta** 43(2), 181-186 2001
79. *Photothermal Spectrometry in Small Liquid Channels* Agnes B. Chartier and Stephen E. Bialkowski **Anal. Sci. (Japan)** 17, i99-i101 2002
80. *Using an Expectation-Maximization Algorithm to Obtain Dielectric Relaxation Time Spectra of Aqueous Montmorillonite Clay Suspensions* Stephen E. Bialkowski, Lynn Dudley, and Dani Or **Applied Spectroscopy** 56 1470-1474 2002
81. *Low Frequency Impedance Behavior of Montmorillonite Suspensions: Polarization Mechanisms in the Low Frequency Domain* Lynn M. Dudley, Stephen E. Bialkowski, Dani Or, and Chad Junkermeier, **Soil Science Society of America Journal** 67 518-526 2003
82. *Steady-State Absorption Rate Models for Use in Relaxation Rate Studies with Continuous Laser Excited Photothermal Lens Spectrometry* Stephen E. Bialkowski **Photochemical & Photobiological Sciences** 2 779-787 2003



Photothermal Spectroscopy Book

Photothermal Spectroscopy Methods for Chemical Analysis
Volume 134 in *Chemical Analysis: A Series of Monographs on Analytical Chemistry and Its Applications*, J. D. Winefordner, Series Editor 1996 John Wiley & Sons, Inc. (ISBN 0-471-57467-8, 584 pgs) local library (QD96.P54B53). It may be found at amazon.com or barnesandnoble.com



- Click here to view the "on-line" version of Chapter 1
- This book concentrates on the theoretical basis and practical considerations required for successful application of photothermal spectroscopy to analysis of homogeneous samples. It provides a nearly complete description of photothermal spectroscopy using a common mathematical language. This systematic approach to the physical basis of photothermal signal generation results in a more complete understanding of why certain problems are encountered in analytical applications and how these problems may be avoided. Information gathered to produce this description draws from analytical spectroscopy, measurement physics, physical optics, and chemical dynamics.
- Three years in the making, it is much more than a collection of old ideas. New approaches to theoretical treatments of hydrodynamic equations resulting in the thermal diffusion and acoustic propagation modes of relaxation, a Fourier optics based diffraction approach to accurate calculation of photothermal signals derived from heat conduction, and the role of energy transfer kinetics on the photothermal signals, can be found in this text. These treatments result in new models that can guide researchers in planning photothermal experiments.



Exhibit C - List of Symposia, Meetings, Panels, Chairmanships, and Professional Affiliations

SYMPOSIA AND MEETINGS ORGANIZED:

- AAAS Pacific Division Meeting Committee 2002-2004
- FACSS Symposium on Photothermal Spectroscopy 1986
- Physical Sciences Division, Annual Meeting, Utah Academy of Science, Arts, and Letters 1988
- FACSS Symposium on Photothermal Spectroscopy 1989
- Physical Sciences Division, Annual Meeting, Utah Academy of Science, Arts, and Letters 1989
- FACSS Symposium on Photothermal Spectroscopy 1990
- Physical Sciences Division, Annual Meeting, Utah Academy of Science, Arts, and Letters 1990
- Physical Sciences Division, Annual Meeting, Utah Academy of Science, Arts, and Letters 1991
- American Chemical Society 45th Annual Summer Symposium on Analytical Chemistry 1992
- Physical Sciences Division, Annual Meeting, Utah Academy of Science, Arts, and Letters 1998
- Physical Sciences Division, Annual Meeting, Utah Academy of Science, Arts, and Letters 1999
- Physical Sciences Division, Annual Meeting, Utah Academy of Science, Arts, and Letters 2000

REVIEWER FOR:

- Academic Press
- Analytica Chimica Acta
- Analytical Biochemistry
- Analytical Chemistry
- Analytical and Bioanalytical Chemistry
- Applied Optics
- Applied Physics E, Instrumental Science
- Applied Physics Letters
- Applied Spectroscopy
- Chemical Physics
- Chemometrics and Intelligent Laboratory Systems
- CRC Critical Reviews in Analytical Chemistry
- Journal of Biomedical Optics
- Journal of Chemical Physics
- Journal of Chemometrics
- Journal of Physical Chemistry
- Journal of the American Chemical Society
- Journal of the Optical Society of America B
- Measurement Science and Technology
- Optics Letters
- Review of Scientific Instruments
- Spectrochimica Acta
- Talanta
- Trends in Analytical Chemistry (TrAC)
- Environmental Protection Agency
- National Institutes of Health
- National Science Foundation
- Petroleum Research Fund
- Research Corporation
- Research Council of Canada

PANELS, CHAIRMANSHIPS, AND OTHER PROFESSIONAL AFFILIATIONS:

- Editorial Board, CRC Critical Reviews of Analytical Chemistry, 1996—present
- International Advisory Board, International Conference On Photoacoustic And Photothermal Phenomena 2001—present

- Web Edition Editor for Society for Applied Spectroscopy, 2002—present
- Participant in US EPA Public Involvement in EPA Decisions dialogue 2001
- Participant in US EPA Libraries as a Community Resource for Environmental Information dialogue 2000
- Consultant, IUPAC Commission On Molecular Structure and Spectroscopy, Quantities, Terminology and Symbols in Photothermal and Related Spectroscopies 1998—present
- Representative in the American Association for the Advancement of Science section on Societal Impacts of Science and Engineering 1999-2002
- FACSS Delegate, Society for Applied Spectroscopy 2000-2002
- Chairman Physical Sciences Division, Utah Academy of Sciences, Arts, and Letters 1987-1991
- Chairman Elect, Society for Applied Spectroscopy, Intermountain Section 1989-1990
- Chairman, Society for Applied Spectroscopy, Intermountain Section 1990-1991
- Chairman Physical Sciences Division, Utah Academy of Sciences, Arts, and Letters 1998-2001
- Chairman Elect, Society for Applied Spectroscopy, Intermountain Section 1998-1999
- Chairman, Society for Applied Spectroscopy, Intermountain Section 1999-2001